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CHANCE AND THE PREPARED MIND[1]

("In the fields of observation chance favors only the mind which is prepared."—Pasteur.)

IT was at the opening of the Faculté des Sciences at Lille on December 7, 1854, that Pasteur, only thirty-two years of age at the time, but already professor and dean of the faculty, uttered these words in upholding, in his inaugural address, the value, on the one hand, of practical laboratory instruction as an aid to the solution of industrial problems, and on the other the importance of investigation in pure science, even though the resulting discoveries might have no immediate application. The point of view may have been novel when it was uttered, but in the sixty years that have elapsed how familiar it has become. How closely it approximates the ideals of those who are striving to improve the conditions of medical education and of medical research in our own day and country. What better argument can the most ardent advocate of detailed practical instruction in laboratory or hospital (medical training at first hand) present, than that which Pasteur offered in 1854. He asks:

> Where will you find a young man whose curiosity and interest will not immediately be awakened when you put into his hands a potato, when with that potato he may produce sugar, with that sugar, alcohol, with that alcohol, æther and vinegar? Where is he that will not be happy to tell his family in the evening that he has just been working out an electric telegraph? And, gentlemen, be convinced of this, such studies are seldom if ever

[1] An address on medical education, by Richard M. Pearce, M.D., University of Pennsylvania, delivered at Syracuse University, May 21, 1912, under the auspices of the Alpha Omega Alpha Honorary Medical Fraternity.

forgotten. It is somewhat as if geography were to be taught by traveling; such geography is remembered because one has seen the places. In the same way your sons will not forget what the air we breathe contains when they have once analyzed it, when in their hands and under their eyes the admirable properties of its elements have been resolved.[2]

Pasteur was a chemist, a physical chemist, if you will, and his illustrations were drawn from the realms of physics and chemistry, but if one substitutes for "electric telegraph" any piece of apparatus now in use in a medical laboratory or a hospital, the principle of the better type of modern medical instruction is embodied in his argument. He was talking to those who, after two years of practical and theoretical study, were to enter industrial careers as overseers and foremen in factories, foundries and distilleries. But neither time nor circumstance fundamentally alters the applicableness of his observations. After sixty years we may still urge his thought as the soundest of principles in the better education of men and women who are ultimately intended to enter careers as our overseers in matters of health and disease and as the foremen of public hygiene. Have our present-day medical schools succeeded in bringing to the training of their students the same practical and scientific thoroughness which Pasteur demanded for students in the industrial sciences and which students of the latter sciences now procure? If not, where lies the fault; in the college or the medical school, in the state or the public? Or are all more or less to blame? These questions will be discussed in due time, but first, let us turn to Pasteur's other proposition, investigation for its own sake. After stating his wish to be directly useful, personally and through his laboratory, to the industries of Lille, he says:

> Without theory, practise is but routine born of habit. Theory alone can bring forth and develop the spirit of invention. It is to you specially that it will belong not to share the opinion of those narrow minds who disdain everything in science which has not immediate application. You know Franklin's charming saying? He was witnessing the first demonstration of a purely scientific discovery, and people round him said: "But what is the use of it?" Franklin answered them: "What is the use of a new-born child?"
>
> Do you know when this electric telegraph, one of the most marvelous applications of modern science, first saw the light? It was in the memorable year 1822; Oersted, a Danish physicist, held in his hands a piece of copper wire, joined by its extremities to the two poles of a Volta pile. On his table was a magnetized needle on its pivot, and he suddenly saw (by chance you will say, but chance favors only the mind which is prepared) the needle move and take up a position quite different from the one assigned to it by terrestrial magnetism. A wire carrying an electric current deviated a magnetized needle from its position! That, gentlemen, was the birth of the modern telegraph. Franklin's interlocutor might well have said when the needle moved "But what is the use of that?" And yet that discovery was barely twenty years old when it produced by its application the almost supernatural effects of the electric telegraph!

This, gentlemen, may seem trite to you, for it is an argument oft repeated, but its significance, as far as medicine is concerned, lies in the fact that at the time Pasteur made these statements modern medical investigation was just beginning. The celebrated physiological institute at Berlin had been in existence only sixteen years; Schwann, following Schleiden, had elaborated the cell doctrine only fifteen years before and anesthesia had been practised for only six years. Claude Bernard was in the midst (1850–60) of his important discoveries concerning the pancreatic juice, the glycogenic function of the liver and the vasomotor system; three years were

[2] Vallery-Radot, "The Life of Pasteur," McClure, Phillips & Co., New York, 1902.

to pass before Virchow established (1855) the first pathological institute and as many again before this great master was to announce the doctrine of cellular pathology; and finally, it was thirteen years before Lister's first publication concerning the antiseptic treatment of wounds.

In all these activities and those which followed, the ideal of seeking for the truth no matter where it might lead—the ideal of pure science—was the secret of that wonderful progress which medicine has made in the last seventy-five years.

Now, however, it is time to return to our text, "In the fields of observation, chance favors only the mind which is prepared." What did Pasteur mean by "chance"? His meaning is very evident in his example of Oersted and the magnetized needle. The mind which is trained to observe the details of natural phenomena, and to reason concerning the bearing of known laws on such phenomena, is the "prepared mind," that is to say, it is a class of mind which, because it is endowed with a peculiar faculty, best described as scientific imagination—grasps the significance of a new observation, or of a variation from a known sequence of events, and thus establishes a new law or invents a new practical procedure. To no man perhaps is this adage of Pasteur more applicable than to himself. It was his work in chemistry and his studies in crystallography that gave him the "prepared mind" which correctly interpreted the significance of the chance observation that the presence of a vegetable mould, the *Penicilium glaucum,* in solutions of salts of the tartaric acids, changed an optically inactive to an optically active fluid. He grasped at once the true interpretation of this reaction. The disappearance of the dextro-tartaric acid, the permanence of the levo-tartaric acid, could be explained only by the assumption that the ferments of this particular fermentation "feed more readily on the right than on the left molecules." So did "chance" direct the "prepared mind" to those fundamental observations which established our present-day principles of fermentation, and which, as the result of work on alcoholic, acetic, lactic and butyric fermentation, led to Pasteur's final dictum:

> The chemical act of fermentation is essentially a correlative phenomenon of a vital act beginning and ending with it.

It was but a short step for the mind thoroughly familiar with the principles of fermentation to embrace the opportunity offered by the study of the etiology of the infectious diseases, and so through all his work, as that in connection with the silkworm problem, vaccination against chicken cholera and anthrax and the treatment of rabies, the "prepared mind" of the great master saw and appreciated the significance of every observation and every opportunity which presented itself.

Many other examples might be presented, as Semmelweis and his observations on the high mortality from puerperal sepsis among those under the care of students fresh from the dissecting and autopsy room and the low mortality among patients under other supervision. So also Lister and his antisepsis; and best of all, perhaps, for purposes of illustration, the sequence of Ehrlich's discoveries. We are told that in his student days Ehrlich was interested above all other things in the study of chemical affinities and worked incessantly with the new anilin dyes. Indeed the story goes that so engrossed was Ehrlich in his work that neglect of the required studies gave rise to some question concerning his right to receive his degree. The situation as described by Christian A. Herter[3] was as follows:

[3] Herter, C. A., "Imagination and Idealism in the Medical Sciences," *Jour. Am. Med. Asso.,* LIV., p. 423, 1910.

Although at this time Ehrlich was especially under the direction of the anatomist Waldeyer, he rapidly developed a capacity for chemistry which was a surprise both to himself and to the chemist, Adolf von Baeyer, whose lectures had been systematically cut by the gifted but unconventional student. For unconventional he then was, and ever has been, neglecting what he did not like and throwing himself with fervor and intense energy into the solution of the themes that attracted him. From the outset it was clear that Ehrlich would make a career as an experimental investigator. Much of the time he was supposed to spend in taking the usual medical courses he devoted to experiment. When Robert Koch was shown through the laboratory at Breslau by one of the professors, his attention was called to a young student working at a desk covered with bottles of dyestuffs. "There is our little Ehrlich," said the professor; "he is a first-rate stainer of tissues, but he will never pass his examinations." The prediction about the examinations came perilously near fulfillment; Ehrlich made bad flunks and it is hinted that he never would have received his degree had he not made a discovery—namely, the existence of the peculiar type of leucocyte which is known to us as the "plasma-cell." The faculty reasoned that it would be improper to keep so promising and original a worker indefinitely in an undergraduate position, and it is suspected that they mitigated the rigor of the examinations in order to relieve their own embarrassment.

These early studies were doubtless responsible for what must be considered as the main theme of all Ehrlich's work—the specific affinity which exists between specific living cells and specific chemical substances. The "prepared mind" is evident in his study of the cells of the blood, of the selective action of methylene blue on the nervous system, of the use of the same dye in the study of oxidation and reductions occurring in tissues, of his studies in immunity, of the specific treatment of protozoan disease, and also according to recent reports in his application of the same principle to the study of cancer. Manson's studies of the relation of the mosquito to filariasis, which led to Ross's study of the transmission of malaria by the same insect, is another example of the "prepared mind" properly interpreting a chance observation. Sometimes such discoveries are referred to as the result of scientific imagination—and it truly is this—but doubtless the same "chance" came to many besides Pasteur, Ehrlich, Laveran, Koch, Theobald Smith, Manson, Ross and Reed; it was the training of these individuals, the mind prepared to utilize scientific imagination, that enabled them to grasp the opportunity offered by "chance" observation. Every one familiar with the history of investigation in medicine knows that before Harvey, men studied the circulation; that before Pasteur, bacteria were seen in diseased conditions; before Lister, the effect of cleanliness upon surgical mortality had been noticed; before Laveran, the plasmodium of malaria had been seen; before Manson and Ross, the possibility of the transmission of malaria by the mosquito had been discussed. Truly,

> remarkable achievements are never unique occurrences in nature. Even the greatest men rest on the shoulders of a large multitude of smaller ones who have preceded them, and epochal discoveries emerge out of a period of intellectual restlessness that affects many minds.[4]

But of these minds, it is that one which is "prepared," trained in the methods of observation, therefore possessing the priceless quality of scientific imagination, which sees the proper block which when placed exactly where it belongs completes the edifice of a perfect theory, and thus establishes a new landmark for future progress.

But what, you ask, has all this to do with the training of the physician? How does it apply to medical education? We admit the value of these qualities in the investigator, but of what value are they to the man seeking the education necessary to

[4] Flexner, S., "The Biological Basis of Specific Therapy," Ether Day address at the Massachusetts General Hospital, October 16, 1911.

practise medicine? Let me repeat Pasteur's adage—"In the fields of observation, chance favors only the mind which is prepared." Certainly all will agree that medicine is largely an observational science and one of the "fields of observation" of Pasteur's definition. Medicine may not be all science, but clinical medicine in its most essential phase—diagnosis—is essentially a science of observation, either of direct observation by the use of the unaided senses or indirect by the use of instruments of precision, or by chemical, biological or other tests. Therefore, whatever force or whatever lesson this adage may carry, applies to medicine. And now as to the interpretation of "chance." I have not been able to obtain the original French of Pasteur, but from his parenthetical phrase in connection with the discussion of the telegraph it is clear that he meant exactly what the translator has given us, chance or opportunity in the sense of an unexpected observation or an accidental occurrence. Pasteur's idea was that such unexpected or accidental occurrences would not arrest the attention of the poorly prepared mind, but that the well-prepared mind, trained to observe, to think and to compare, would grasp the significance of the unexpected, the unusual or occasional, put the observation to the test, by experiment or control, and arrive at the correct conclusion. Is not this a matter of daily occurrence in clinical medicine? Does not chance (opportunity some would call it) and care in details play an important part in diagnosis? Is not every ailment the physician sees a puzzle; every diagnosis, if correct, a solution of that puzzle? One speaks of the man who solves the puzzle which has baffled half a dozen other men, as a keen or accurate diagnostician. They imply that he has an added power, or that his skill is the result of wider experience, forgetting they may have seen as many individuals with the malady as had the consultant, and perhaps totally ignorant of the fact that his diagnosis was possibly based on a chance observation which meant more to his trained imagination than it did to minds unaccustomed to weigh the significance of details. Every clinician of experience can give examples of the importance of chance and imagination in actual diagnosis. An interesting illustration is that

> of the two students who reported on the same patient in competition for a clinical prize. The patient presented, among other symptoms, a remarkable discoloration of a certain area of skin, and the first student described this discoloration with the most careful minuteness. He measured it in different directions and drew a rough sketch of its general outline. The second observed the phenomenon with equal care, but he exercised his imagination and formed a hypothesis which he proceeded to put to the test. He asked a nurse for a wet towel, with which he wiped the discoloration away. It is evident that the faculty which he thus brought to bear on the problem before him would be likely to stand him in good stead in relation to many others of a more complicated character; and that his exercise of the art of diagnosis would be practically immune from the errors incidental to the habit of taking all appearances at their face value. Imagination at once points to the possibility of more than one explanation of any given occurrence, or alleged occurrence, and compels inquiry as to the existence of probable causes beyond the particular one which may at first sight appear to have been in operation.[5]

From what has been said, then, it should be evident that it is the first duty of a medical school to prepare men properly for the practise of medicine (and the most ardent advocate of research in the university will not deny that this is the first duty). If so, what are, conditions to be fulfilled to ensure the "prepared mind" of Pasteur's adage?

The Preliminary Education of the indi-

[5] "Imagination in Medical Research," *Lancet*, 1912, CLXXXII., 179.

vidual is the first and in many ways the most important consideration. I know it is bringing coals to Newcastle to discuss this question before the students and faculty of Syracuse University, for you have been among the first to recognize the value of two years' college work which shall include physics, chemistry and biology. Still this principle is not generally recognized. Many of those in positions of authority in our medical schools, while loudly proclaiming the right of medicine to a place among the sciences and indeed characterizing it as the "Mother of the Sciences," deny that a scientific education is a prerequisite to medicine. True, the opposition is frequently due to a realization of the awkward financial position in which an administration might be placed if students' fees diminished. Frequently also it is due to the claims of those who hold that a greater cultural value lies in following the humanistic rather than the scientific school of thought. Naturally, there is also the "poor boy cry" and the closely associated cry that outlying districts will not be properly cared for if the cost of medical education is increased. The "poor boy" argument may be dismissed at once, for those who have had experience in teaching medicine know that the boy, poor or otherwise, who knows what he wants in the way of an education, gets that education in spite of all difficulties, and as a rule, if he has to work for it, is keen enough to get the best that is to be had. Such men will "come through" despite all apparent barriers in the way of higher preliminary requirements; if the indifferent "poor boy" fails, lacking ambition and a clear conception of what he wants, so much in favor of the higher requirements.

As to the outlying districts, we need have no fear as long as the ratio of physicians to population is 1 to 568[6] and the use of the automobile is increasing. If the ratio should change greatly, which does not seem likely, for only two states[7] (North and South Carolina) have a ratio of less than 1 to 1000, the matter then becomes one for state regulation, for, as the report of the Carnegie Foundation has shown, we have enough physicians, but the difficulty lies in the tendency of physicians to seek the larger civic centers.

With the discussion of the cultural value of humanistic as compared with scientific studies, we are not concerned. It is sufficient that in a university medical school a man can not properly study modern medicine without that knowledge which comes from a familiarity with laboratory work in physics, chemistry and biology. The value of biological training for those interested in practical medicine was emphasized by Huxley many years ago, and that in physics and chemistry has recently been emphasized by Friedrich Müller[8] in describing, for the benefit of the English Commission, the training of the German medical student.

During his first and second year,[9] the medical student attends lectures and does laboratory work in physics, chemistry, botany and zoology in the philosophical faculty, and he has the opportunity of widening his views by listening to lectures on philosophical or historical subjects. His teachers and laboratories are the same as for the students of the natural sciences, and this is right, because there is no such thing as special medical physics

[6] Flexner, A., "Medical Education in the United States and Canada," Bull. No. 4 of the Carnegie Foundation for the Advancement of Teaching, 1910.

[7] *American Medical Association Bulletin,* 1910, V., 278.

[8] Müller, F., "Memorandum on Medical Education Submitted to the Royal Commission on University Education in London."

[9] The German student seldom takes his state examination until the end of five and a half years' work (Müller).

or chemistry; the physician requires a broad knowledge of the general sciences of physics and chemistry.

It is most important to have this statement of Müller's at a time when an effort is being made to place physics, chemistry and biology in the medical curriculum. With or without a fifth year it is a dangerous policy. The experience of one school in this regard is enlightening. During the period of change from a high school to a two-year college requirement, conditioned men were cared for by allowing time in the first half of the first year to make up conditions. The procedure took eighteen hours a week from the time which should have been devoted to purely medical studies. In such an emergency as that of a change of policy, this was perhaps justifiable, but what university school with a four-year course can afford this arrangement as a permanent policy? And if we are to have a fifth year, progress demands that it should be a clinical or hospital year, and not a preliminary year for work which belongs to the college. The modern curriculum of a first-grade medical school demands a student's full time and attention and no amount of general culture can make up for absence of prerequisites in physics, chemistry and biology. The school which allows mixed requirements, or low requirements or conditions does so at the expense of efficiency; the good men suffer on account of the slow progress of the poorly trained; the inefficiency of the teaching under such circumstances becomes noised about, and it comes to pass that the best-trained men go to schools which take only their kind, and thus eventually low standards react on the school allowing them.

But this is not all. Another factor, the state, is beginning to play an important part in determining the conditions prerequisite to medical education. Five[10] states have passed laws demanding that for license to practise medicine an applicant must have had two years of college work as a minimum requirement, and four[11] demand one year. This, we must admit, is only the beginning. As state after state adopts the same ruling, schools not demanding such preparatory study must see the territory open to their graduates (and therefore the territory from which they draw students) gradually narrowed. Certainly, to-day, no school, and certainly no university school, can face with equanimity, this discrimination; and "disappointed indeed will be that student who, after having spent a large amount of time and money, finds on graduation that his diploma is not recognized in a large number of states."[12]

Methods of Teaching.—Within the medical school itself the matter of educational policy is clear. Here there can be only one procedure, the constant and consistent employment of the "do it yourself" or "learn by doing" method; the student must be taught to observe, experiment, reason and act for himself. This, I know, is trite, but the conditions out of which our present methods of medical education have emerged demand that this point of view be continually emphasized. It is not long since the day of the two- and three-year course and the imparting to undergraduates of all medical instruction, outside of anatomy and inorganic chemistry, by lecture. The development of the laboratory branches, histology, pathology, bacteriology, physiological chemistry and pharmacology—and the cheapening of physiological apparatus

[10] Colorado, Indiana, Iowa, Minnesota and North Dakota.

[11] Connecticut, Kansas, South Dakota and Utah.

[12] *Jour. Am. Med. Asso.*, LVII., p. 1138, 1911; LVIII., p. 487, 1912.

—have given a new turn to medical teaching, that of active participation by the student. But still even in these branches the lecture still persists in most schools and frequently is so magnified in connection with the laboratory instruction as to make it appear in the eyes of the student as the most essential part of the course. The advance in methods and means of practical laboratory instruction—that is, the visible machinery for developing the principle of teaching by actual observation and experiment—would seem in some schools to be an equipment for advertising purposes only. One does not have to go outside the group of our so-called "big" schools to find a department of pathology, abundantly equipped with apparatus and a wealth of pathologic material, offering five lectures a week; and one may find an elaborately equipped student's laboratory of physiology manned by assistants while the head of the department fulfills his duty to his class with three or four lectures a week; and likewise, in the clinical branches, few men have had the courage to do away with frequent and voluminous lectures. Even schools controlling a large hospital, and sometimes several, and thus having an abundance of clinical material, do the bulk of their teaching by the formal lecture and the amphitheater clinic. The ward class and the clinical clerk system gain ground but slowly. The reason for this attitude is easily found. The lecture is the easiest form of teaching, and the average teacher, whether he be the laboratory man overburdened by executive detail and handicapped by lack of assistants, or the clinical teacher limited in time by a busy practise, follows the lines of least resistance, forgetful, though sometimes resentfully so, of the best needs of his class. Usually coexistent with a pernicious lecture system is the habit of leaving those most favorable fields for proper education—the laboratory exercise and the ward or dispensary class—to assistants. No one has less desire to belittle the work of assistants or to lessen their independence than have I, but in the department in which the head lectures only the student naturally assumes that the work of subordinates—in laboratory or clinic—must be work of subordinate importance, and thereby he comes to have a wrong estimate of the live part of his education. The most ardent supporter of the lecture system can not say that he always holds the interest of his class. He may hold their attention and be flattered by copious note-taking, but this has for its object only one purpose—the final examination. The real education—the training which means power and which characterizes "the mind which is prepared"—can come only through independent but wisely directed observation, experiment and reasoning on the part of the student.

I have discussed elsewhere[13] how the latter system may be fostered, and am now glad to be able to reinforce my position by quoting from the recent very excellent address on this subject by Professor G. M. Jackson.[14] As to the share of the teacher Professor Jackson says:

> It is evident that each teacher must understand the curriculum as a whole. The laboratory man must be familiar with the clinical work. But this is not all. Since good teaching must take into account that which has gone before as well as that which is to follow, it is equally evident that the clinical man must be familiar with laboratory subjects and methods. We can not expect the best results in medical education until there is a better understanding and more cooperation between teachers of the various subjects all along the line.

[13] Pearce, R. M., "The Experimental Method: Its Influence on the Teaching of Medicine," *Jour. Am. Med. Asso.*, LVII., p. 1017, 1911.

[14] Jackson, G. M., "On the Improvement of Medical Teaching," SCIENCE, XXXV., p. 566, 1912.

As medicine progresses, all phases appear more clearly as varied manifestations of the same underlying biological science, and only when this is realized will the clinical and laboratory work be more closely knitted together.

As for the student, it is suggested that he work out everything for himself by the method of discovery. This applies not only to the original observations, but also to the latter process of reasoning, whereby we proceed from particular data to general conclusions, and thence to rational action. The method of self-activity may therefore be expressed in a negative way by the following practical rules: Never tell a student anything he can observe for himself; never draw a conclusion or solve a problem which he can be led to reason out for himself; and never do anything for him that he can do for himself.

There are, of course, limitations to the application of this method, as lack of time, an overcrowded curriculum, inability on the part of the teacher to fully grasp the situation, and failure to always maintain sustained effort on the part of the student, but its value over the lecture system is so great that it should be followed in "so far as practicable" (Jackson) and should be supplemented by demonstrations and conferences or recitations rather than by lectures, if one truly seeks to prepare properly for the practise of medicine.

Influence of the Spirit of Investigation.—But aside from this training the university has another duty to the prospective practitioner of medicine. This is its duty in the encouragement of investigation, which is indeed a double duty, a duty to its students and a duty to the community it serves.

The question of allowing undergraduates to undertake independent original investigation is, I know, a debatable one. Certainly in most schools our overcrowded curriculum renders such work impossible unless a wise arrangement allows elective studies, as at Harvard in the fourth year, or as at Johns Hopkins in each year. My remarks on this subject are therefore based on the assumption that an elective system is possible in every school.

As every teacher knows, each class contains a considerable number of men who desire to pursue work, to a greater extent than the conventional course allows, on certain subjects or by special methods, or less frequently, perhaps, they desire, and are usually well qualified to undertake, minor investigative work. To the former, as well as to the latter, any effort spent in work beyond that given the entire class becomes, necessarily, for them, the acquirement of the methods of research and as this means a knowledge of the exact, painstaking methods by which the realms of the unknown are explored, it is an exercise which prepares the student for the daily routine research work of the physician who truly practises his profession. As a training for future work, its value is definitely known and the increased zest and enthusiasm exhibited toward their medical work by men who have had this opportunity are always evident. Pedagogically, therefore, it would seem advisable that every student should have the opportunity for minor investigative effort, in order that he may become acquainted at first hand with the careful methods of experimental medicine. The bearing of the tangible results of his work on the subject investigated is a matter of little or no importance; the vital thing is the increased power which he himself acquires.

There is another way in which the encouragement of research aids the student, but which is possible only to those schools following the wise policy of appointing to professorial chairs, teachers who are likewise investigators. The influence of such teachers in the development of independent and resourceful practitioners is the secret of the great success of our better schools.

The correctness of this statement may be easily demonstrated.

If one examines courses in the same subject in a number of schools it is found that those which are best presented are under the control of men actively engaged in research work. Such men are alive to the advantages of new methods in their own subject and of new ways of applying old methods. Ever thinking and pondering about new methods of acquiring knowledge for themselves and their science, they appreciate better than does the non-investigator, that which will aid the student to acquire knowledge, and in their teaching they bring to bear on the problems which the student has to face the same methods of attack which they use in their own researches. On the other hand, one finds the men who never or only occasionally contribute to the literature of their science are the men who confine their teaching to perfunctory routine courses, with a profusion of lectures, and who never bring the spirit or methods of the investigator into their teaching. So, likewise, it is with the student taught under these two conditions. The student who knows that he is working in a department actively emphasizing new methods and striving to develop new truths, knows that his instruction is presented in the spirit of the department, and thus receives that stimulus and inspiration which insures his approaching clinical medicine with a proper appreciation of the scientific method. The student under the method of the non-investigator, on the contrary, has no incentive other than that of acquiring a knowledge sufficient to allow him to pass an examination.

An allied argument lies in the fact that the medical school that fosters research attracts the best-trained men as students. We have, as is well known to many of you, a medical school in this country which has, for several years, arbitrarily selected from a large number of prospective matriculants the certain definite number which it desires; the rest, sometimes nearly fifty per cent. of those accepted, go elsewhere. Now this school has the highest requirements and perhaps the smallest alumni body of any prominent school in the country. It is not, therefore, a question of easy entrance or of the loyal influence of alumni, nor is it a question of better laboratory and hospital facilities, for other schools have equally good equipment in both respects. Likewise it is not a question of geographic location or center of population. The enviable position of this school is due solely to the policy of combining research with teaching and of appointing to its staff teachers who, with few exceptions, are also investigators.

As to the duty of the university to the community in the matter of research, there can be only one opinion. If the purpose of the machinery of medical education is to "bring healing to the nations," if the business of medicine is to "get people out of difficulties through the application of science and dexterity, manual and physical" (Cabot), then it is the duty of the university not only to teach known principles and methods, but to advance knowledge and methods by research.

It is futile to say that it is sufficient to teach and to utilize known methods of freeing people from difficulties, for the mere statement of such an attitude implies that an obligation exists to extend known methods, or to invent new ones, in the hope of overcoming difficulties acknowledged to be at present without remedy. The ethical force of this statement can not be denied. To teach a subject implies the attempt to diffuse the available knowledge of that particular subject matter among a number of people for their good, as well as for the good of the community in which they live

and work; equally true is it that such an attempt to teach available knowledge imposes upon the teacher the obligation to leave untried no means by which the knowledge of his subject may be increased. It is not the privilege of the teacher to leave this extension of knowledge to others. His profession of ability to teach a particular subject carries with it his obligation to the group or community he serves, of adding to his subject knowledge of which they may avail themselves. If this applies to the individual teacher, how much more forcibly does it apply to the university with its ever-widening community and ever-increasing interests?

On the other side of the question, the university should not forget that medical research tends to ameliorate social conditions by diminishing the causes of physical and mental ills. This ideal of medicine the university and its community should foster and develop, for it is one of the greatest influences in our modern conception of social service; an influence indeed which was back of all Pasteur's work, and which he expressed in the statement of his desire to contribute "in some manner to the progress and welfare of humanity."

But aside from this altruistic ideal, I hold that research in the medical school offers important practical advantages to the university and that these advantages should not be forgotten by university authorities, who pride themselves on applying business-like methods to the problems of education. A policy which attracts a better-trained class of students, which improves the character of the instruction, which stimulates the student to a better type of individual effort and which enhances the standing of the university in the community and the nation is a policy which can not be ignored by university president, trustees or faculty.

The Relation of the Hospital to Medical Teaching and Research.—That the laboratories of our better medical schools are fully equipped for the kind of instruction which I have outlined, and that many are already fostering the "do it yourself" principle and the spirit of investigation is well known. In the clinical years, on the other hand, the situation is not so satisfactory. Many a medical school while building and equipping modern laboratories has failed to care properly for its clinical teaching, and has continued to foster the amphitheater lecture. If the method of first-hand instruction, which I have outlined, is to be followed, then the hospital must become the laboratory of the clinical years and a school must own or absolutely control its hospital. This is necessary in order (1) that the heads of the clinical departments may have a continuous service under their immediate charge and to the conduct of which they may bring their own assistants; (2) that in connection with such service they may develop laboratories for teaching and research in addition to the usual clinical laboratory now used only for purposes of diagnosis; and (3) that resident physicians may be appointed for indefinite service in order that trained teachers and investigators in clinical medicine may be produced in the same way as trained teachers and investigators in the laboratory branches are now produced, and (4) that the head of the department may provide adequately for that intimate first-hand clinical instruction which can be secured only by placing the student in actual contact with the patient.

Some schools, as Pennsylvania, Hopkins and Jefferson, have already solved the problem by the establishment of their own hospitals. This is naturally the ideal course for all university schools and a future for which every school should plan. But in the absence of the possibility of im-

mediate consummation of such an ideal, results almost as satisfactory may be obtained by the actual affiliation of municipal or independent hospitals with the stronger medical schools. A hospital has as much to gain by this arrangement as has the medical school, for while the chief duty of the hospital must always be the care of the sick and injured, this duty, as well as its other functions—the instruction of men who are to practise medicine and the advancement of medical knowledge by research—is best served by placing the conduct of the hospital in the hands of men highly trained in the methods of scientific medicine.[15] This would not only enable the hospitals

> to fulfill a greater function in the development of thoroughly qualified physicians, but it would also be best for the patients, since they would have the benefit of the best methods of treatment under recognized experts. A campaign of education should be carried on to show our municipal authorities that the hospital will be the best conducted in the interests of its patients and the community at large, if at the same time it is fulfilling its function as a great center of clinical teaching and research.[16]

Many examples may be presented of the ideal association of charity, teaching and research as the results of such affiliation; the most striking perhaps being the magnificent clinic of Müller in Munich and the clinics of the University of Leipzig. Here, as in many other continental cities and in England, the university authorities by agreement with the municipal authorities appoint the heads of the hospital clinics. The long continuance of this arrangement and the great fame of most of these clinics is sufficient proof that both municipal authorities and university authorities find it mutually advantageous.

> We should bring about the same state of affairs in this country and, in fact, a start has already been made. At Cincinnati the large municipal hospital has been placed in charge of the clinical teachers of the University of Cincinnati; in St. Louis, the Washington University has made a close affiliation with the new Barnes Hospital; in Boston, Harvard has made an affiliation with the Peter Brigham and several other special hospitals; in New York, Columbia University and the Presbyterian Hospital have established similar relations; in Cleveland, Western Reserve University has formed a combination with the Lakeside Hospital; in Chicago, Rush Medical College has had for a number of years the medical control of the Presbyterian Hospital, and recently has made similar contracts and arrangements with the Children's Memorial Hospital, the Home for Destitute Crippled Children and the Hospital for Infectious Diseases.—Bevan.[17]

How much better such an arrangement would be than that which now exists. At present in most schools the clinical teacher is a teacher mainly because he is fortunate enough to control a hospital service, and for this reason has been appointed on the university staff. In his appointment the school has no choice, for it must have for its students the advantages of the clinical material which he controls. Whether he be good, bad or indifferent, as physician, teacher or investigator, he must be retained as long as he holds his hospital position. He, on the other hand, is handicapped by the regulations and restrictions of a not always sympathetic lay board of hospital management and, more important still, by the absence of proper laboratory facilities and the aid of his own colleagues in the departments of bacteriology, immunology, pathology and pathological chemistry. These departments are coming more and more into active participa-

[15] For a discussion of the advantages to be gained by the hospital, see Welch, W. H., "Advantages to a Charitable Hospital of Affiliation with a University Medical School," *The Survey*, XXVII., p. 1766, 1912.

[16] Bevan, A. D., "The Modern Medical School," *Jour. Am. Med. Asso.*, LVIII., p. 652, 1912.

[17] Bevan, *loc. cit.*

tion in hospital work, in diagnosis, prognosis and treatment, and should be as closely affiliated with the hospital as are the clinical chairs. Those of you who have read "The Corner of Harley Street,"[18] a most delightful series of letters by an English consultant, may remember the words quoted by the author from a lecture of a brother consultant to postgraduates. Said the lecturer:

> Gentlemen, I should like the day to dawn when I could be met at the door of my hospital by a trained chemist, a trained bacteriologist, a trained pathologist, so that when I come to some complicated case I could say, "Chemist, a part of this problem is yours, take it and work it out. Bacteriologist, perform your share in elucidating this difficulty. Pathologist, advance, and do likewise."

These are not idle words. Since Ziemssen in the middle eighties established in Munich the principle of a clinical laboratory in the hospital, the idea has spread rapidly, until now every hospital worthy of the name has its clinical laboratory for the routine procedures of diagnosis. But this is not sufficient. The clinical chief must have the close cooperation of his colleagues in the departments of pathology, bacteriology, physiology and chemistry, and the student likewise must have the outfits of these departments at hand to aid him in his clinical studies. It is no longer enough to depend on the simpler procedures for the examination of urine, sputum, blood and other body secretions and fluids. The transportation across the city of tissues or fluids for examination in the laboratories of the school can no longer be countenanced. The progress of modern medicine, especially in pathological chemistry and immunology, demands for the benefit of the patient as well as for the proper instruction of the student, detailed and oftentimes prolonged examinations under the hospital roof or at least within the boundaries of the hospital yard, and under the control not of assistants or internes, or dependent on occasional visits of a professor of pathology, bacteriology or chemistry, but under the constant supervision of such experts who do their teaching and research in the hospital and contribute their share to the diagnosis, care and treatment of the ills of the patients. This is the ideal of social service in medicine, the goal of all effort in medical education and research; and it is not Utopian. Already the University of Toronto has transferred its departments of pathology, bacteriology and pathological chemistry to the grounds of the hospital which furnishes its clinical instruction. Here not only the elementary instruction is given, largely aided by an abundance of fresh material from the hospital, but each advanced student serving as clinical clerk in the wards has always his desk, well-equipped locker and special outfit for the detailed investigation of his clinical material by laboratory methods, and moreover, has always at hand his teachers in the laboratory branches to aid him in his clinical investigations. It was my good fortune recently to go over these departments with Professors Leathes and MacKenzie, who explained their workings to me. When I expressed my satisfaction at the ideal union of clinical and laboratory methods Professor Leathes said quietly, and as if there could be no other point of view, "Yes, we expect a student working in the wards to use in diagnosis the methods of pathological chemistry as he does his stethoscope." Do you know what this means? It means that the amphitheater clinic and the didactic lecture are to follow the two-year and three-year course and that the methods and instruction of the

[18] "The Corner of Harley Street, being some Familiar Correspondence of Peter Harding, M.D.," Houghton Mifflin Co., 1911.

laboratory years are no longer to be divorced from the clinical teaching of the later years of the curriculum. It means that men are to be trained by the "do it yourself" method to become practitioners with power of accurate diagnosis and the "mind which is prepared" to take advantage of every "chance" observation and opportunity. It means that the newer methods of biological, physical and chemical diagnosis, evolved through laboratory effort, are to work a transformation in medical teaching and medical practise analogous to that which came in the middle of the past century through the introduction of exact methods of physical examination. As physical diagnosis raised medicine above the plane of objective diagnosis and revealed the morphological changes in diseased organs of the interior of the body, so now the methods of physiological chemistry and immunology are destined to reveal the changes in the cells and fluids of the body which are dependent on intoxication, infection and altered metabolism and thus bring about an advance in methods of diagnosis, the fruits of which are almost beyond our powers of imagination.

Herein lies the most potent argument for close affiliation of school and hospital. The task, both from the teaching side and from the research side, demands united effort, common use of material and common financial responsibility. While any contract between university and hospital must leave the general support of the hospital in the hands of the hospital management, the school must be prepared to pay the salaries of attending staff, the cost of equipment and the expenses necessary for teaching and research and to assume the responsibility for the medical and surgical care of the patients and the general conduct of the scientific work. On the other hand, the hospital should leave the matter of appointments, subject to its nominal approval, entirely in the hands of the school, with the understanding that withdrawal or resignation from the school automatically would sever connection with the hospital, and *vice versa*. Such an arrangement settles most of the problems of medical education. Continuous service and freedom in the appointment of clinical teachers come as a matter of course. Teaching and investigation can be carried on without interruption. The student becomes a part of the hospital routine and is not an onlooker with limited privileges. The laboratory departments of the first and second years unite to aid the work of the clinicians in the hospital. Clinical teachers may be promoted, if deserving, or may be called from any part of the country, or from abroad; the choice no longer depends on local hospital appointments or on the selfish interests and friendships of local consultants, but on fitness, eminence and skill.

Teachers may be appointed on a university basis, devoting all or most of their time to the care of the patients, to teaching and to investigation. The heads of the departments of internal medicine and surgery certainly should be so appointed. Under such circumstances these men with their staffs could control a large body of students working relatively independently among the patients in the wards and in the special laboratories in or near the wards. In these clinical laboratories every student should have his own desk and outfit for microscopic, chemical and other methods of examination. Not merely apparatus for the simpler tests should be supplied, but as well every facility for prolonged bacteriologic examination, animal inoculation and detailed chemical and physiologic study.

Such a plan insures diagnostic ability and therapeutic skill by training the powers of direct observation as well as by instruction in the methods of indirect observation through the use of instruments of precision and the procedures of the chemical and biologic laboratories. The experimental method emphasized in the laboratory years is thus continued through the clinical years. Laboratory procedures naturally fall into their proper place in relation to the methods of direct observation, and as the student approaches each new disease in the spirit of the investigator and not as an onlooker he gains a point of view which can not fail to have an important bearing on his work as a practising physician.

The Hospital Year.—So much for the preparation which the training, facilities and opportunities of the modern medical school should offer as leading to the degree of doctor of medicine. Should the state and the public demand more? Yes, the state, through its machinery for the protection of the individual, should demand a fifth year of hospital work, and this the public would force the state to demand if the easy-going public was thoroughly familiar with the insufficient requirements of many of our state licensing boards. Indeed, some states are already drafting laws to protect their citizens from the products of the poor medical schools of a neighboring state—

> For example, the state of Minnesota has enacted a law enforcing an educational qualification as to the training of physicians who are allowed to practise in that state. The law was adopted in order to protect citizens of Minnesota against the graduate of commercial medical schools in neighboring states, and particularly of Chicago. In the present state of medical education such a measure is entirely justifiable.[19]

[19] Pritchett, H. S., "Education and the Nation," *The Atlantic Monthly*, April, 1912.

Such a law not only protects the community against the improperly prepared graduates of the poor school, but it encourages the good medical school to increased efforts.

The hospital year as a prerequisite to licensure is to-day a live topic of discussion; to-morrow it may be in this and in other states a requirement legally stated.[20] Indeed it is difficult to see how the progressive state of New York, the educational system of which is so wisely controlled by a special board of regents, can much longer delay in establishing such a requirement. But why wait for the regents to force this upon the schools? Already 80 to 90 per cent. of the men in the better schools secure hospital appointments. Why should not the schools compel the small minority of those who do not secure a hospital to take a fifth year in clinical instruction in the hospital which it controls and thus be prepared for the requirement which must inevitably come in this and other states. I realize fully that the deans of our various schools are divided on this question. Some take the position that although the hospital year is an excellent requirement, the burden of finding the hospital instruction for all its graduates should not be placed on the school; that the duty of the university is ended when it has given four years of instruction and that the fulfillment of the added requirement is an affair of the individual. What does this mean in the last

[20] There is only one school at present which requires the fifth hospital year, and that is the University of Minnesota. No state boards at present require the hospital interne year. Those which to a certain extent have initiated practical tests at their examinations are Massachusetts, Minnesota, Ohio and North Dakota, and to a lesser extent practical tests are being used in Colorado and Michigan. (Personal communication from N. P. Colwell, secretary, Council on Medical Education of the American Medical Association.)

analysis? Simply this, that a school holding this point of view is either lax in its entrance requirements or at fault in its methods of instruction; otherwise it would not fear the failure of its graduates to secure interneships. If this is true it has under the circumstances but one duty: as an educational institution, it must itself provide the fifth year of hospital work for its lame students. This is the point of view which is gradually forcing itself upon the school of the better grade, which, now that the pioneer stage of medical education is past, desires to itself complete the student's preparation, instead of turning him "over to others during this most valuable and important part of his preparatory work."[21] The proposition of Professor Peterson, of Michigan, that the council on medical education of the American Medical Association should conduct an inspection and classification of hospitals on the same basis as the inspection of medical schools is most timely. The data thus obtained would do much to clarify the situation, and, doubtless, mutual agreements between certain schools and certain hospitals of the same class could be reached as to the distribution of graduates for interne service. Such a systematization would allow school and hospital alike to see their defects and to so rearrange their work as properly to care for the greatest number of properly prepared men. Only through the hospital year can we give the best type of practitioners to a most deserving but too confiding public; but to bring about the consummation of this ideal every university school and every community possessing a modern hospital must do its share.

These general remarks cover, in my opinion, the cardinal principles which should guide the modern medical school. They can not, perhaps, in every community be enforced at once in their entirety, and doubtless now and then their adoption may be followed by backsliding, but no one who has given the subject serious thought can doubt that the future of medical education in this country depends on (1) the university school with a high entrance requirement, (2) instruction, in both laboratory and clinical branches, based on the method of observation and experiment, (3) clinical instruction in a hospital which the university owns or controls, (4) the principle of a fifth year of hospital instruction and (5) the fostering of the spirit of research.

And now finally let me congratulate Syracuse University on the high ideals it has set for itself in the conduct of its medical school. Your course has been watched by all who are interested in medical education. Your responsibility is greater than perhaps you realize; there are those praying for you to continue your present progressive system, others hoping you may fail. Each group desires to point to you as an object lesson. I have full confidence, however, that the wise trustees of your university, supported and encouraged by your alumni and the physicians of Syracuse and its surrounding territory, will not only maintain the present high standards, but will inaugurate still greater advances and thus ensure for the practitioner of medicine in this community the "prepared mind" of Pasteur's adage.

R. M. Pearce

[21] See Peterson, R., "The Relation of the Medical School to the Interne or Hospital Year," *Jour. Am. Med. Asso.*, LVIII., p. 723, 1912.

THE WORK OF COLONEL GORGAS

The degree of doctor of laws was conferred on Colonel W. A. Gorgas by the Johns Hopkins University on June 11. In presenting him for the degree Dr. William H. Welch said: